IMAGING LENS

This application is a Divisional of application Ser. No. 11/528,477, filed on Sep. 28, 2006, now U.S. Pat. No. 7,295,386 the entire contents of which are hereby incorporated by reference and for which priority is claimed under 35 U.S.C. § 120.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a fixed-focus imaging lens which can be suitably mounted on a small-sized imaging apparatus such as a digital camera using an image device such as a CCD (Charge Coupled Device) or a CMOS (Complementary Metal Oxide Semiconductor), a camera using a silver film, etc.

2. Description of Background Art

In recent years, with the popularization of personal computers over general homes or the like, digital still cameras (hereinafter referred to as "digital cameras" simply) capable of inputting image information of photographed scenes, persons, etc. into personal computers have been coming into wide use rapidly. With the sophistication of cellular phones, module cameras (portable module cameras) for inputting images have been often mounted on cellular phones.

In such an imaging apparatus, an imaging device such as a CCD or a CMOS is used. With recent development in miniaturization of imaging devices, such an imaging apparatus as a whole has been highly miniaturized. With higher pixel counts in imaging devices, higher resolution and higher performance have been developed.

For example, imaging lenses for use in such a miniaturized imaging apparatus have been disclosed in the following patent documents. JP-A-10-48516 and JP-A-2002-221659 disclose imaging lenses with three-lens configurations respectively. JP-A-2004-302057, JP-A-2005-24581, JP-A-2005-4027 and JP-A-2005-4028 disclose imaging lenses with four-lens configurations respectively. The imaging lens disclosed in JP-A-2004-302057 has a stop disposed between a second lens and a third lens from the object side. The imaging lens disclosed in JP-A-2005-24581 has a stop disposed the most closely to the object. The imaging lens disclosed in each of JP-A-2005-4027 and JP-A-2005-4028 has a stop disposed the most closely to the object or between a first lens and a second lens from the object side.

As described above, with the miniaturization and the higher pixel counts in recent imaging devices, particularly imaging lenses for digital cameras are requested to have higher resolution performance and to have a compact configuration. On the other hand, imaging lenses for portable module cameras have been heretofore chiefly requested to be low in cost and compact in configuration. Recently, also portable module cameras have showed a tendency to make their imaging devices higher in pixel counts. Thus, the imaging devices in the portable module cameras have been requested to have higher performance.

It is therefore desired to develop a wide variety of lenses comprehensively improved in cost, imaging performance and compact configuration. For example, it is desired to develop low-cost and high-performance imaging lens having compactness secured to be high enough to be mounted even in a portable module camera, and having performance high enough to be mounted even in a digital camera.

To meet these requests, for example, it is considered that the number of lenses is three or four in order to secure compactness and low cost, and aspheric surfaces are used aggressively in order to secure high performance. In this case, the aspheric surfaces contribute to compactness and high performance. However, the aspheric surfaces are disadvantageous in terms of manufacturing efficiency, and the cost is increased easily. It is therefore desired to take the manufacturing efficiency into consideration when the aspheric surfaces are used. The lenses according to the aforementioned patent documents have a three-lens or four-lens configuration using aspheric surfaces. However, they are insufficient, for example, in terms of compatibility between imaging performance and compactness.

SUMMARY OF THE INVENTION

An object of an illustrative, non-limiting embodiment of the invention is to provide an imaging lens showing high imaging performance in spite of its more compact configuration.

An imaging lens according to one aspect of the invention includes: in order from an object side of the imaging lens, a first lens having a convex surface on an object side and having a positive power; a second lens having a concave surface on the object side and having a negative power; a third lens having a positive power; and a fourth lens having a convex surface on the object side near a paraxial axis and having a meniscus shape; wherein the imaging lens satisfies all the following conditional expressions (1) to (5), where; f**1** designates a focal length of the first lens, f designates a total focal length, n**1** designates a refractive index of the first lens at the d-line, v**1** designates an Abbe number of the first lens at the d-line, f**2** designates a focal length of the second lens, and f**3** designates a focal length of the third lens.

$$0.7<f1/f<1.1 \quad (1)$$

$$1.45<n1<1.6 \quad (2)$$

$$v1>60 \quad (3)$$

$$0.8<|f2/f|<1.8 \quad (4)$$

$$1.9<f3/f<20 \quad (5)$$

An imaging lens according to one aspect of the invention can be made compact because the number of lenses is small to be four, while it is possible to obtain imaging performance high enough to support a digital camera which is, for example, mounted with a 5 million pixel imaging device. Specifically, since the first lens has a power satisfying the conditional expression (1), increase in size can be suppressed, and increase in spherical aberration can be suppressed. Further, since the first lens is formed out of a lens material satisfying the conditional expressions (2) and (3), chromatic aberration on the axis can be reduced. Further, since the imaging lens is arranged to satisfy the conditional expressions (4) and (5), high-order aberration such as spherical aberration or coma aberration can be corrected excellently, and the imaging lens can be made compact.

Preferably the imaging lens according to one aspect of the invention may be arranged to further satisfy the following conditional expression (6), where: bf designates a distance (on air basis) from an image-side surface of the fourth lens to an image plane, and TL designates a distance (on air basis) from an object-side surface of the first lens to the image plane. When the imaging lens is arranged to satisfy the conditional expression (6), more sufficient back focus can be secured

$$bf/TL>0.2 \quad (6)$$